Factors associated with player satisfaction and educational value of serious games

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Abstract

Computer games are well established forms of entertainment which have been shown to promote the development of important cognitive skills. This has also seen their evolution into games supporting training and education, known as serious games. In order to investigate those factors that would be important when developing these types of games we conducted a two year study on undergraduate game development students. Seventy four students participated in the study. They were asked for their views on three web-based serious games (Cancer Game, Darfur is Dying and Elude). A series of study questionnaires were used to collect data on their playing experience, satisfaction with the games and how well they acquired subject specific knowledge after playing them. The students' views on the games' entertainment and educational value were mixed. Two games (Cancer Game and Darfur is Dying) were able to increase players' knowledge as a result of playing them but to differing extents. Suggested improvements to the games focused on providing more appropriate background information on the subject within the game, and giving the player better feedback on how to play it. When the results were compared to existing heuristics on game development improvements to the design of the game interface, game mechanics and game playability were identified. The need to incorporate learning outcomes into the games and that they be outcome based are also important pedagogical factors. In this initial study we have suggested a series of heuristics which the authors believe will be important to developers of serious games.

Keywords Serious games, heuristics, usability, play, education

1.0 Computer Games

Computer games have been identified as being able to develop important skills for example improving perception (both attentional and visual), cognition and behavior as well as affective and motivational status (Connolly 2012).The challenge to developing these types of games is balancing both the entertainment and educational values. Some of the educational design strategies that have been used include constructivist, experiential and discovery based learning, as well as situated cognition (Kebritchi and Hirumi 2008). Enjoyment, happiness, and intention to use are considered to be important factors for playing these types of games and are

also needed for increased learning performance (Giannakos 2013). By using appropriate learning outcomes interest in the subject being taught within the game can be increased. This can lead to improved performance in tests and it helps to support the transfer of acquired knowledge and skills into the real-world. Reducing the amount of time it takes to teach a subject and lowering the overall teaching costs are considered to be effective benefits associated with using serious games (All et al. 2015).

There are several excellent texts on how to make games for entertainment (Rollings and Adams 2003; Fullerton, Swain and Hoffman 2004; Braithwaite 2008; Schell 2008). These authors' recommendations revolve around identifying important aspects and constituent components of existing games and then subsequently proposing how they could be used to develop new ones. Design patterns have also been suggested as one way in which games could be developed (Björk and Holopainen 2005). These authors propose that by combining existing game scenarios or mechanics in different ways new games can be produced. Despite information being available on how to develop games there is less information on how to develop serious games. Research often focuses on their evaluation as an educational medium rather than the processes used to make them (Kebritchi and Hirumi 2008; All et al. 2015).

Reducing the possibility for unexpected events that can result in the failure of a system is important in any software development. Usability engineering is a range of techniques that put the user at the centre of the software design process (Nielsen 1993). Similarly the involvement of the players in the development of games can help to identify bugs, understand their experiences; what works within the game and what does not. Even with extensive play testing it cannot be guaranteed that the game will be a success. Heuristics are another way of guiding the development of systems. The principle relies on the use of expert knowledge to construct processes or "rules-of-thumb" for their development. This approach has also been investigated for use in game development (Federoff 2002; Desurvire et al. 2004; Pinelle et al. 2008; Desurvire and Wiberg 2009).

In a case study by Federoff (2002) ten usability heuristics, as proposed by Nielsen (1993), were compared to practices being used in the development of a game at a professional studio. As a result three areas were identified which include heuristics for game interfaces, game mechanics and game playability. In their studies Desurvire at al. (2004) propose a model called Heuristic Evaluation for Playability (HEP). They looked at four components of games which included game play, game story, game mechanics and game usability. Game play encompasses the challenges that the player must overcome in order to win the game. The story comprises the characters and plot, whereas the game mechanics determine the components of activities and actions that make up the game. Game usability defines how well the user can successfully interact with it. The study was conducted on a new game being developed by the authors. They found that HEP proved effective in identifying playability issues relating to both game story and game usability. They initially concluded that HEP was useful in early game design and best

suited to finding known general issues that can occur in the early development phases using either prototypes or a mock-up of a game. Subsequent studies identified that HEP was only useful in limited circumstances leading to the proposal of a model of Heuristics of Playability (PLAY) (Desurvire and Wiberg 2009). This model was developed and tested on a series of games including real-time strategy, action and adventure as well as first-person shooters. The premise of the work was to develop a broad list of heuristics that could be used to form the foundations for development or modification of specific games. From their work Desurvire and Wiberg (2009) identified that designing games was as much an art as a science. Pinelle et al. (2008) developed their heuristics by analyzing reviews of 108 PC games from a popular gaming website. The research led them to argue that game usability should address issues of entertainment, engagement and storyline given that both artistic and technical issues are related. As a result of reviewing the literature on game development heuristics, Koeffel et al. (2009) identified 29 potential components that could be applied to the evaluation of a computer game. They postulated that the more usability issues that are found during a heuristic evaluation, the less likely that the user will get a poor experience. By applying their heuristics to five computer games they identified a positive relationship between problems within the game and player ratings given to it on the metacritic.com website. The recommendations found in these studies (Federoff 2002; Desurvire et al. 2004; Pinelle et al. 2008; Desurvire and Wiberg 2009; Koeffel et al. 2009) are varied but there are some aspect that are common to each of them which relate to game interface, game mechanics and game playability. These are summarized in Table 1.

Heuristics have also been recommended in the development of serious games however there are only limited studies in this area. Omar and Jafaar (2010) focus on five aspects which include interface, pedagogy, multimedia; content and playability. In terms of the educational value they recommend games have both clear goals and learning objectives. The activities within the game should be engaging too. Other important aspects include that the game should facilitate self-directed learning, be a medium for active participation and performance should be outcome-based. Despite these recommendations, their paper only focused on the theoretical side to developing serious games as they did not test their suggestions on any actual games.

Table 1. **Summary of common heuristics associated with developing games**

Category	Item
Game interface	Controls should be customizable.
	The user interface should be customizable.
	There should be appropriate mechanisms in both visual and auditory form which can provide feedback to the player.
	The player's game world view should be clear and unobstructed.
	A player should always be able to identify their score/status in the game.
Game mechanics	The learning curve of the game should not be too steep.
	The game should be responsive to the particular player's needs.
	The game should provide meaningful feedback.
Game playability	The artificial intelligence should be functional.
	The player should be able to easily navigate the game world.
	Provide clear goals, present overriding goal early as well as short-term goals throughout play.
	Challenges, strategy and pace should be in balance.
	The game should be learnable.
	The game should be re-playable.

1.1 Project aims

From a new or inexperienced developer's perspective it is important to understand those factors which are associated with the successful development of a game. This can reduce the guess work involved in their development, leading to a reduction in the overall time it takes to make the game and potentially reducing the number of mistakes made during its creation. The series of studies discussed in this chapter are intended to investigate a range of usability factors associated with serious games. Three games were selected from the Games for Change website (http://www.gamesforchange.org/), 'Cancer Game', 'Darfur is Dying' and 'Elude'. All three are simple web–based games which can be played in approximately 10 minutes. The information about the games on the website describes the Cancer Game as being developed so that players can investigate the symptoms and causes of cancer. Through its game play it challenges players to learn about good health practices. The premise of Darfur is Dying is to give the player an insight into the plight of the millions of refugees that live in the Darfur region of Sudan and

the genocide that is occurring there. Elude was designed to raise the player's awareness and understanding of the issues people face when living with clinical depression. The studies were conducted during two academic years between 2013 and 2015. In this chapter the authors will:

- Describe the development of a series of questionnaires aimed at evaluating the entertainment and educational value of these serious games.
- Analyze play testers' views on the usability and their satisfaction with the games.
- Compare the authors' findings with existing heuristic models for game development as outlined in Table 1.
- Based upon the research, propose recommendations for developing serious games in future.

2.0 Methods

2.1 Participants

A total of seventy four 1st year undergraduate students studying BSc (Hons) Computer Games Technology at Birmingham City University (UK) participated in the study. Two separate cohorts were involved, one during the academic year 2013/2014 (n=42) and another during 2014/2015 (n=32).

The study was conducted during one of their scheduled 3 hour classes on game design. All the students were asked to play as many of the three games as they could through to their completion and subsequently answer a questionnaire on each of the games.

The first cohort of students (2103/2014) was asked to complete a questionnaire giving their views on player experience, satisfaction and the educational value of each of the games. From the information gathered from this part of the study the second cohort of students (2014/2015) were asked to complete three different questionnaires one for each of the games. The questions were derived from a thematic analysis of responses to the first questionnaire. They related to both general and specific usability issues and satisfaction with each of the games. They also included a pre-post test knowledge quiz with questions relating to each game. This was used to assess their understanding of the subject matter associated with it.

2.2 Study questionnaires

Questionnaire 1: Player views and experience. The questions in this questionnaire were general in their scope and relevant to all the three games. They included questions on demographics of the players and their gaming habits. It also asked for their views on the perceived educational value; player satisfaction and their suggested improvements for each of the games. Table 2 lists the questions.

Table 2. Questionnaire 1: Player views and experience cohort 2013 /2014

Theme	Question
Demographics	What is your age range?
	How often do you play games?
	Which game platforms do you use?
Questions	What was the game trying to teach you about?
	List three main elements that the game taught you?
Opinions	List four things you liked about the game.
	List four things you least liked about the game.
	Would you play the game again?
Ratings	Rate how enjoyable you felt playing the game was.
Improvements	How would you improve the game play?
	How would you improve the game to make it more educational?

Using Microsoft Excel version 2007, two of the co-authors (CB and BM) independently coded the responses to each of the questions, for each game, before exchanging the data between themselves and repeating the coding. This process was conducted a total of three times until a series of final themes were identified. Subsequently a second set of questionnaires were developed.

2.3 The game specific questionnaires

Based upon the information gained from questionnaire 1, three questionnaires, one for each of the games, were developed (Tables 3 and 4). The questionnaires covered the following topics as well as game specific information:

- What did the game teach the players?
- What did they like and least like about the game?
- What improvements could be made to the game play?
- What improvements could be made to the educational content of the game?

The game specific questionnaires collected information on player demographics, their game playing habits as well as their views on the games' entertainment and educational value. They were also asked for their suggestions as to how to improve these aspects. These questionnaires also focused on evaluating the player's subject knowledge before and after playing each of the games. The original game developers did not include educational objectives or measures of knowledge acquisition with their games. Therefore a series of pre and post-test questions were created for this purpose which was also based upon the themes identified from questionnaire 1. The post-game play questionnaire also asked participants where they had found the answers to the questions for example by play-

ing the game, reading content associated with it or by looking up information on the Internet. Table 3 shows the range of questions asked for each of the games whereas Table 4 lists the specific pre and post test questions asked for each game.

Table 3. Generic questions in the game specific questionnaire 2014 /2015

Theme	Questions
Demographics	What is your age range?
	How often do you play games?
	Which game platforms do you use?
Opinions	Where did you find most of the information to answer the questions?
Ratings	How well did you feel that the game raised your awareness and gave you information about the subject?
	Overall how would you rate the game?
	How would you rate the graphical style of the game?
	How would you rate the sound in the game?
	How good was the information and feedback that was given to you whilst playing the game?
	How fun was the game?
	How difficult was the game to play?
Improvements	What could be done to improve the game?
	What could be done to improve the education experience of the game?

Table 4. Generic questions in the game specific questionnaire 2014 /2015

Game	Questions
Darfur	What is happening in Darfur?
	What country is Darfur in?
	Approximately how many refugees do you think are in the Darfur region?
	Who are the people in Darfur in conflict with?
	What roles do women and children play in Darfurian society?
	In Darfurian society what risks do people face?
	What risks to their homes and possessions do they face?
	What are the most precious resources to Darfurians?
	How do they use this resource?
	What charities are raising awareness of issues in Darfur?
Elude	How much does depression affect people's lives?
	List four ways depression can affect an individual.
	List three mood states that can be associated with people living with depression.
	List three ways depression can be positively overcome.
Cancer Game	Who can cancer affect?
	How have you previously learnt about or found information about cancer?
	List four parts of the body that cancer can affect.
	List four things that you could do to reduce your risk of getting cancer.
	What's the end motto of the game?

3.0 Results

3.1 Demographic

The participants were aged between 18-25 years old and predominantly male (93%). Fifty three respondents played games on a daily basis, 15 a few times a week, 3 played only a few times a month and 1 only played occasionally.

3.2 Evaluation of serious games for playability and educational content

The following sets of results were derived from the initial 2013/2014 study using questionnaire 1. Each student could provide multiple responses to items, for example what the game taught them, as well as what they liked and least liked about it. The data is presented as the number of responses made to each theme. Similar responses made by the same individual were only counted as one response.

3.2.1 Cancer Game

Thirty nine students responded to the questionnaire. When asked what they thought the Cancer Game taught them, four themes were identified. These were how to avoid cancer (n=20), followed by how to live /eat healthily (n=12), learning about the human body (n=5) and the effects of cancer and how it spreads (n=3). When asked what they liked about the game, responses included the game's aesthetics (n=17), its mechanics (n=11), the educational aspect (n=9) and the concept (n=6). Seven themes emerged when asked what they least liked about the game. These were that the game was confusing (n=22), the visuals of the game were not very good (n=10), the time it took to load the game (n=9), it was boring (n=7), it lacked relevance (n=6), it was too linear (n=5) and lacked feedback (n=4). When asked how to improve the game play suggestions included addition of more information and hints within the game (n=14), less point and click (n=5) as well as better feedback and visuals (n=4). Improvements to the educational aspect included more facts about cancer (n=13) as well as better information and feedback within the game (n=8). Indicative suggestions for improvements to the game play and educational value include:

"*The controls could have been done a little better so that the player knows what to do*."
"*Add some more interactivity, some movement instead of point and click*."
"*I think more hints provided throughout the game would have made the game more educational*."
"*Give the player hints or at least tell them what to do on each level*."
"*Once a level is completed have an explanation of what type of cancer and ways of preventing it*."
"*The game assumes you are aware of everything about cancer. It should inform you about the lack of a cure and the research into cancer*."
"*actually indicate what the player is doing as they play through*."
"*Put captions for each action that player does explaining what is happening. The gameplay can't explain it all*."

3.2.2 Darfur is Dying

Forty two students responded to the questionnaire. When asked what they thought Darfur is Dying taught them three themes emerged. These related to the living conditions the citizens experience (n=31), the conflict that exists between citizens and the militia (n=11), as well as the need for foreign support and medicine (n=4). When asked what they liked about the game four themes were identified. These included raising awareness of the situation that exists in Darfur (n=19), the mechanics of the game play (n=19), the visual aesthetics of the game (n=9) and its difficulty and intensity (n=7). What they least liked about the game were the mechanics of the game (n=22), that the game was boring and repetitive (n=11), that the game was unclear and confusing (n=10) and the visual aesthetics of the game (n=9). The data showed that there was contradictory information re-

garding the responses for both liking and disliking both the game mechanics and its aesthetics. When asked how to improve the game play suggestions included improving the controls and instructions (n=11), add more challenges and their variety (n=11) and improve the graphics (n=6). Improvements to the educational aspect included adding explanatory cut scenes or animation (n=6) in order to provide more background information about the crisis in Darfur (n=6). Suggestions to improve the game play and educational content included:

"*Provide more information to the users on how to play*."
"*Provide more user feedback, reduce large blocks of text and find more immersive ways of getting information across*."
"*Make foraging more skill based, make camp construction easier to understand, make story more integral and less wall of text*."
"*Give a different graphical style as I didn't quite feel the threats with the cartoony style*."
"*Include more facts about the crisis to make people more aware*."
"*Elucidate on how this is not only happening in one country but others too. "*
"*Add more consequences, give stats at the end of the game e.g. starvation."*
"*Add videos to show what is really happening in Darfur*."
"*Add extra option to the menu – questionnaire / quiz. Help the user make sure they have learnt something*."
"*Make it more visceral. Less text more showing the events of what happened in the region*."

3.2.3 Elude

Forty two students responded to the questionnaire. Analysis of their responses to what they thought the game taught them revolved around raising awareness of depression (n=18) and understanding that mood changes can occur in this condition (n=9). The respondents liked the game's aesthetics (n=27), its games mechanics (n=24), the awareness raising element of the game (n=10) and its simplicity (n=6). What respondents least liked were that they found it boring and repetitive (n=15), its mechanics (n=8), the outcome of the game (n=4); and that it was unclear what to do and too hard (n=4). Similarly to Darfur is Dying, items such as game mechanics were cited as being both liked and disliked by the respondents. Overall improvement in the actual game play (n=11) were suggestions as to how to improve the game. More background information to clinical depression would improve the educational value (n=29). Suggestions to improve the game play and educational content included:

"*Provide a map to tell players where they are and where the objects are in the level*."
"*A way to trace how well you are doing in the game*."
"*Have the environment slowly progress. An explanation of the purpose of both birds and pulse power*."

"*Add an ending, add more objectives, have a more significant progression."*
"Clear objectives, better instructions."
"*Facts about depression. Explain how depression affects people. Explain the stages of depression*."
"*Make story slightly more obvious and give clear indications as to the objective of the game*."
"*State ways of how to avoid depression and the bad effects of depression*."

3.3. Rating and re-playability of the games

When the respondents were asked whether they would play these games again of the 39 who played the Cancer Game only three said they would. Of the 42 who played Darfur is Dying and Elude only 5 said they would replay the former and 10 the latter. Participants were asked to rate each game from 1- poor to 10 excellent. Table 5 shows the responses to each game. None of the games scored above 8, with the cancer game not scoring more than 7. If we calculate the number of ratings above 5 for each game, Darfur is Dying faired the best with 20 responses, followed by Elude (n=17) and the cancer game (n=12).

Table 5. Player rating of each game

		Overall Rating of Game									
	No. of Responses	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Elude	42	5	7	9	4	1	6	9	1	0	0
Cancer Game	38	8	9	5	4	6	2	4	0	0	0
Darfur is Dying	40	2	5	8	5	12	7	0	1	0	0

3.4. Knowledge quiz

The pre-post test knowledge quiz was conducted on 32 students in the academic year 2014/2015. Data is presented as mean ± s.d, analysis was conducted with the Wilcoxon Signed Rank Test using the MaxStatLite statistical software package. Table 6 shows that students increased their subject specific knowledge after engaging with the games Darfur is Dying and Cancer Game, but not the Elude game.

Table 6. Number of correct answers to game specific questions

		Number of correct answers to quiz	
Game	**Number of responses**	**Pre game**	**Post game**
Cancer Game	32	7.1 ± 1.61	8.6 ± 1.16 ***
Darfur is Dying	31	3.9 ± 3.23	11.2 ± 2.33 ***
Elude	28	3.6 ± 1.13	3.3 ± 1.62

Data represented as mean ± s.d. Wilcoxon Signed Rank Test ***p<0.001

3.4.1. Cancer Game

Thirty two students answered the quiz. Mean correct responses to questions prior to playing the game were 7.1 ± 1.61 and after 8.6 ± 1.16. Twenty five students answered the questions as a result of just playing the game whereas 7 answered questions as a result of reading the accompanying text to the game, using the internet or combinations of these. Of the 25 that just played the game the mean correct responses to questions before playing were 7.2 ± 1.60 and after 8.5 ± 1.1 ($p<0.001$).

3.4.2. Darfur is Dying

Thirty one students answered the quiz. Mean correct responses to questions prior to playing the game were 3.9 ± 3.23 and after 11.2 ± 2.33. Fifteen students answered the questions as a result of just playing the game whereas 16 answered questions as a result of reading the accompanying text to the game, using the internet or combinations of these. Of the 15 that just played the game the mean correct responses to questions before playing were 3.5 ± 3.23 and after 10.9 ± 2.64 ($p<0.001$).

3.4.3. Elude

Twenty eight students answered the quiz. Mean correct responses to questions prior to playing the game were 3.6 ± 1.13 and after 3.3 ± 1.62. Fourteen students answered the questions as a result of just playing the game whereas 12 answered questions as a result of reading the accompanying text to the game, using the internet or combinations of these. Of the 14 that just played the game the mean correct responses to questions before playing were 3.6 ± 1.34 and after 3.2 ± 1.63.

3.5 Player satisfaction

The second cohort of students was also asked questions around seven themes that had emerged from questionnaire 1. These questions related to the level of awareness and subject information that the game gave the player, rating of both the games' graphical style and sound quality as well the quality of information and feedback given to the player; how fun the game was and the level of difficulty as-

sociated with each of the games. Players were also asked to give an overall rating of the game. Ratings for all of these questions were from -5 (very bad) to +5 (very good). Table 7 shows the percentage of responses that were either in the negative or positive ranges for each of the questions, together with a calculated difference between the two values. All of the games were rated more positively for each of the questions except the quality of the sound in Darfur is Dying and the level of fun in Cancer game which were rated more negatively. Some of the items were less differentiated than others with negative and positive opinions being closer to each other. This included for the level of awareness of the subject matter in Elude, the graphical style of Darfur is Dying, the level of information and feedback in the Cancer Game and Elude, the level of fun in the Cancer Game and Darfur is Dying, as well as the difficulty level of Cancer Game.

The second cohort of students was also asked about their views on how to improve each of the games, in terms of game play and educational value. Suggestions for the Cancer Game included improving feedback and information both for how to play it (n=12) and for providing education (n=15). This was a similar response in Darfur is Dying with 12 individual responses citing more feedback and information being needed in both these aspects. Clearer game play objectives (n=23) and feedback on issues relating to depression (n=18) were cited as possible improvements to Elude.

Based upon the calculated difference between the positive and negative values the order of satisfaction with the Cancer Game was graphical style, awareness, overall rating of the game, its sound, the level of difficulty, the level of feedback and how fun it is. With Darfur is Dying the order was awareness, overall rating of the game, level of feedback, level of difficulty, its graphical style, how fun it is and its sound. With Elude the order was graphical style, its overall rating, difficulty level, its sound, how fun it is; the level of feedback and how well it raised awareness of the subject matter.

Table 7. Comparative analysis of player perceptions and satisfaction with each game

	Cancer Game			Darfur is Dying			Elude		
	-ve	**+ve**	**Difference**	**-ve**	**+ve**	**Difference**	**-ve**	**+ve**	**Difference**
How well did you feel that the game raised your awareness and gave you information about the subject?	22.6	67.7	45.1	9.7	90.3	80.6	36.3	51.5	15.2
How would you rate the graphical style of the game?	22.6	74.2	51.6	41.9	58.1	16.2	6.1	93.9	87.8
How would you rate the sound in the game?	6.5	32.3	25.8	29.0	19.4	-9.6	6.1	48.5	42.4
Overall how would you rate the game?	29.0	67.7	38.7	16.1	83.9	67.8	3.0	87.9	84.9
Quality of Information and Feedback.	38.9	51.7	12.8	12.9	74.2	61.3	32.4	52.9	20.5
Fun.	48.3	32.3	-16	35.4	48.4	13.0	27.2	66.7	39.5
Difficulty.	32.3	51.7	19.4	29.0	54.8	25.8	9.1	72.3	63.2

Data is presented as the percentage of number of respondents (Cancer Game n=31, Darfur is Dying n=31 and Elude n=32) that rated the item as being either negative or positive. Responses that were given a zero rating have not been included. The difference between the positive and negative results has also been calculated.

3.6 Comparison with heuristics

Based upon the information gathered in this study and playing the games the authors rated them for how well they felt they achieved the common heuristics which were identified in Table 1. The games were rated as to whether the items were not present, there was limited implementation or the implementations were either acceptable, good or excellent (Tables 8a & b).

Table 8a. Comparison of each game with common heuristic associated with game development

Category	Item	Cancer Game	Darfur is Dying	Elude
Game interface	Controls should be customizable.	NP	NP	NP
	The user interface should be customizable.	NP	NP	NP
	There should be appropriate mechanisms in both visual and auditory form which can provide feedback to the player.	L	G	A
	The player's game world view should be clear and unobstructed.	G	G	G
	A player should always be able to identify their score/status in the game.	NP	A	NP
Game mechanics	The learning curve of the game should not be too steep.	L	A	G
	The game should be responsive to the particular player's needs.	L	G	G
	The game should provide meaningful feedback.	L	G	L

NP-Not Present, L- Limited, A–Acceptable, G-Good and E-Excellent

Table 8b. Comparison of each game with common heuristic associated with game development

Category	Item	Cancer Game	Darfur is Dying	Elude
Game playability	The artificial intelligence should be functional.	NP	A	NP
	The player should be able to easily navigate the game world.	L	G	G
	Provide clear goals, present overriding goal early as well as short-term goals throughout play.	L	G	A
	Challenges, strategy and pace should be in balance.	L	G	G
	The game should be learnable.	L	G	G
	The game should be re-playable.	L	L	G

NP-Not Present, L- Limited, A–Acceptable, G-Good and E-Excellent

Of all three games the Cancer Game lacked many of these key attributes or there was only limited implementation. Darfur is Dying and Elude had more items that had an acceptable or a good level of implementation however none of the games were considered excellent given the responses that were made by the players during their analysis of them.

4.0 Discussion

The three games evaluated in this chapter were originally created to raise awareness of particular issues such as cancer, mental health (depression) and genocide. The authors were interested in how each of them achieved these objectives by assessing both players views and measuring educational content. In the first section of this discussion the authors we will give a brief overview of the each of the games.

4.1 Review of the games

The Cancer Game requires the player to navigate different levels representing the lungs, liver, stomach and intestine. Within each organ there are a series of activities associated with cancer prevention and suggestions for a healthy eating and lifestyle. For example in the lung level the player needs to select drugs to defeat the ‘enemy’ cancer, before clearing a path to collect a key which allows the player to leave that level. In the liver the character has to match a series of icons of healthy drinks in order to stop the flow of alcohol into a machine which represents

the liver. By using a drug the player kills the cancer allowing them to collect another key so they can then move to the next level. Similar activities occur in the stomach and intestine levels; each time the player has to defeat the 'enemy' cancer by using drugs and progress through the level by selecting healthy foods to help them.

Darfur is Dying describes itself as a narrative-based simulation. There are two main activities within the game. The first one involves foraging for water and the second one involves using the water to manage resources within their camp. At the start of the game you are required to select a Darfurian citizen to forage for water. The character has to reach the water well avoiding being captured by the militia. The character is able to run and hide behind objects whilst 'enemy' characters chase them in their vehicles. Feedback in the form of a dialog box indicates to the player the distance and location of the well. Once the player has collected the water they have to navigate back to their village without being intercepted by the pursuing enemy militia. The game mechanics in this section provides the player with elements of both risk and challenge. If the player character is caught by the militia this section of the game ends and information is presented on the screen highlighting the types of risk the player's character may encounter in Darfur. The player can then move onto the next section of the game which is managing the Darfurian camp. This requires the player to continue to collect water so that they can maintain the camp's gardens in order to grow food and use the water to make bricks so they can build shelters. In combination with visits to the medical centre, these activities are needed to keep the player healthy so that they can subsequently maintain the camp as long as they can whilst avoiding attacks from the militia.

Elude is a platform based game with simple game mechanics that requires the player to take control of a character, moving and jumping onto tree branches in order to navigate the game world (forest). A puzzle element involves the player trying to find the best route through these trees in order to reach the sky and then ascend higher by jumping on game objects such as flowers and leaves. If the player moves or jumps inaccurately they can miss these items and fall back to their starting point, the forest floor. This gives the game a strong element of skill, challenge and risk.

4.2 Comparison of player views of the three games

Players felt that Darfur is Dying was better at raising awareness when compared to the Cancer Game or Elude and as a result of playing it produced the largest overall increase in knowledge acquisition. However the players stated that the game could be further improved by supplying more background information. Elude was rated higher than the other games for several factors which included its graphical and audio style. It was also rated higher than the other games for its mechanics, level of fun and how challenging it was to play; as well as scoring high in its overall rating as a game and the one players' would potentially play again. Players stated that they felt they were more aware of the issues associated with

depression although this was not demonstrated by any significant change in their scores in the knowledge quiz.

4.3 Comparison to published heuristics

The next section discusses how the three games reflect those heuristics that were previously summarized in Table 1. As these heuristics were originally developed to assess commercial PC and video games, rather than serious games, we have also included discussion of how the games meet the education requirements (clear learning goals, learning outcomes and be outcome based) as proposed by Omar & Jafaar 2010 and Giannakos 2013.

Make the game fun to play, easy to learn with no repetitive or boring tasks. Provide a variety of challenges to maintain player interest and enhance the game's replay-ability

By their nature games should be fun to play and engaging otherwise players will quickly lose interest and stop playing them which also has obvious consequences if the game is intended to be educational. Of the three games evaluated both Elude and Darfur is Dying were considered to be relatively more fun to play than the Cancer Game with Elude being the one that players rated highest. Elude could have been considered to be the more fun for the players and initially easy to learn because its mechanics are based upon a familiar and well established genre (platformer). It also had more challenges and risks in its game play, requiring the player to develop their skills in order to proceed through the game. Darfur is Dying also used risk and challenges in its game play however this was more prominent in the foraging for water section rather than in the camp management. The players felt this part of the game to be unclear and confusing leading them to feel that the game was a little boring and repetitive. The Cancer Game was also criticized for lacking fun. The downside being that many of the player actions are down to 'trial and error' as a result of them having to perform random 'point and click' actions in order to interact with the game and game objects. The sequence of activities required to complete each level are always the same so there is no variety or challenge for the player, subsequently the players felt this game to be boring and lacked relevance. By adding more variety of tasks, more challenges and risks to the games players are required to develop their skills in order to master them. This could help reduce repetition, make the game less boring and help to encourage replay-ability.

Make the game aesthetically pleasing

The graphical and visual style of a game can be very important to players. However the responses of the players showed that opinion can be divided even on the same game. This is not unsurprising given that games are considered forms of art and perceptions of what constitutes appealing graphics to one person can be different to others. Of the three games Elude was rated highest by the players for its graphical and audio style which may reflect their higher quality. Darfur is Dying was criticized by one player feeling that the threats within the game were lessened as a result of the cartoon style of graphics. Players' views on the visual and

audio style of the Cancer Game were mixed although these were rated lowest of all the three games.

Use different graphical, audio and visual channels to promote immersion; provide feedback to users on how to play the game and as a way of supplying important background information on the educational topic. Have clear meaningful goals and objectives within the game which are supported by hints and immediate feedback which support the player if they get stuck or confused

Poor quality of feedback was a recurrent theme for many players of the games. Criticism was focused on the limited information available on how to play them as well as poor background information on the subject matter. Of the three games Darfur is Dying had the most information within it. This was in the form of 'pop-up' dialog boxes that give textual information about the situation occurring within the region and information on the activities the player needed to perform within the game, for example which gardens to water; prompts that medicines had arrived or attacks by the militia were imminent. However players still felt the instructions for managing the camp and its resources were limited and sometimes confusing. Overall players suggested the need to provide alternative ways of presenting information on the situation that was occurring in Darfur and rather than using large blocks of text adding videos, cutscenes and animations would be more helpful. Despite this, the level of information contained within this game most probably resulted in the players' better performance in the knowledge-based quiz. Neither Elude nor the Cancer Game provided feedback on how to play them and outside of text accompanying the game on their respective websites, any supporting information about what the game was trying to teach the players.

Provide clear ways that players can identify their score, status, progress and achievements within the game

Players progress within a game, their achievements and knowing whether they have won or lost are important. Only Darfur is Dying provided this type of information. Within the camp section a graphical user interface gave the player information about the camp's status. Information included the relative levels of water and food supplies, the overall health status of the camp; the level of threat from the militia and the day number indicating the player's progress in maintaining the camps survival. Elude and the Cancer Game did not display any information to the player on their progress. The players therefore felt that this made the game more difficult to learn and how to succeed in, leading to confusion as to what the outcome and (educational) objectives of the game were.

Ensure that the player can easily navigate the game world and environment and can customize it if required

Frustration can often occur in games when players are not able to do what they want, get to where they want to or when the game reacts in unexpected ways. In the absence of providing tutorials and explanations it is important to make the game as intuitive as possible to play. Darfur is Dying did make some attempt at providing the players with guides as to how to play it for example by selecting icons on game objects 'pop-up' menus with relevant game information were dis-

played. However the players still felt that these were not always as helpful as they could have been. Elude's game play is based upon a well know genre with recognizable mechanics which made it initially more intuitive to play. The Cancer Game provided no guide as to how to play it leading to confused players who commented on the need to give them hints and show them what to do on each level as well as giving indications as to what the player is doing and achieving as they play through the game. The Cancer Game would have benefitted from the introduction of either a short tutorial or time dependent feedback. In this situation players who were not engaging in particular tasks, within an appropriate time frame, would have been given some assistance early on. This could have reduced the level of frustration and confusion in not knowing what to do, rather than the players feeling that they had to rely on guess work in order to complete the game. By allowing the player to be able to customize the environment for example by setting the level of difficulty and relative levels of feedback novice players can learn to play the game quickly but it can also make it more challenging for more experienced players when that information is reduced or removed.

Make sure the controls are appropriate to the game, where possible customizable and easy for the player to use so that they feel that they are in control of the game. Pay attention to accessibility issues; user interface and user experience when designing games especially for players who may have a disability

Players need to interact with games and recognizable mechanisms and conventions for input have existed for some time. For example PC games are often controlled by using the keyboard keys WASD or the Arrow keys for movement, the space bar for jumping and mouse for navigation and looking around the environment. By using this standardized approach players can quickly learn to play the game through familiarity of action. However players may feel they are more comfortable and in control of the game by choosing alternative mechanisms. Darfur is Dying and Elude allowed players to play the game using the arrow keys but there was no option to use the WASD keys. The Cancer Game relied solely on point and click navigation. Some players may have preferred to use game pads and controllers too. However it is acknowledged that some game development environments or gaming platforms do not always have the scope to provide a range or different types of input for the user. Inclusivity is also an important consideration when designing serious games for example for players who may have physical limitations or some level of disability. Players may need access to different types of input controller; players with poor visibility may need more audio feedback or the ability to adjust the layout of the screen to their particular requirements. People with hearing impairments may need to adjust sound levels or will be more reliant on visual cues for their feedback.

If artificial intelligence is used then it should be functional

Competition is an important element of games. This may take the form of competing against a fellow player or against the game itself. In the latter case artificial intelligence is used to represent the opponent. High quality reliable artificial intelligence can be difficult to achieve as its accuracy can be very dependent upon how

well the game is optimized in order to work. If the game speeds up or slows down then the artificial intelligence can become out of synchronization with the actual game play. Darfur is Dying was the only game to use some level of artificial intelligence. One noticeable flaw in its execution was that that when the militia chased the player character they did not always follow them allowing the player to exploit this allowing them to escape. This was only a minor issue but when implementing artificial intelligence as it must be perceived by the player to function correctly, it must be believable to the player and result in enhancing the game play rather than disrupting it.

Provide learning outcomes from the beginning so players know what they are expected to learn. This should be reinforced by providing appropriate feedback and subject specific information within the game

Serious games are intended to be educational and players are expected to learn from them. Based upon the findings of this study each of the games did achieve the objectives but to varying extents. Based upon the player feedback Darfur is Dying provided them with insights into the plight of the refugees that live in the Darfur region of Sudan and the genocide that is occurring there. The Cancer Game allowed players to investigate the symptoms and causes of cancer as well as learning about good health practices but the players felt this was achieved only to a limited affect. Elude raised player's awareness of the issues people face when living with clinical depression but this message was not always clear to the player. Of all three games, playing Darfur is Dying resulted in a significant increase in knowledge acquisition by the players. There was a small but significant increase after playing the Cancer Game and no significant change as a result of playing Elude. When the players were asked for comments on these games they felt that the associations between the game objectives and the educational message (cancer prevention and depression) were sometimes difficult to discern.

Each of the games provided an explanation of what they were trying to achieve on their websites. This could have been further enhanced and the players' attention focused more by providing more explicit learning outcomes or objectives. These could be set at the start of the game or associated with supporting material for example on the game's website. The latter has more flexibility for offering alternative learning outcomes depending upon the audience or what the emphasis in learning should be given a particular teaching scenario. If the learning outcomes are based within the game then they are fixed.

Learning should also be reinforced within the game. Darfur is Dying was the only game to do this. Feedback was provided within it by adding dialog boxes supplying the player with additional information. Progress within the game was supported by menus and graphical user interfaces. However its approach to providing feedback was criticized by the players with too much reliance on large blocks of text which disrupted the game play. This resulted in suggestions for alternatives ways of presenting the information for example incorporating video showing the plight of the Darfurians which may have also been a more powerful way of conveying the intended message.

In summary we can posit that Darfur is Dying was better at providing an educational experience owing to the greater depth of information that it contained whereas familiar game mechanics, aesthetics, fun and difficulty, as seen in Elude, were more indicative of the "better" game.

5.0 Limitations of the work

The study was conducted on seventy four 1st year undergraduate computer games technology students of which sixty eight (92%) could be considered regular gamers. We did not collect data on the number of years they had been playing games, yet the indication was that prior to the study they would have had substantial experience of playing them and therefore would be able to provide critical and knowledgeable evaluations of the three games.

The authors' research identified that there was a lack of clear pedagogical objectives associated with the games. This meant that the authors had to create their own questionnaires. This was done through analysis of the responses from the first cohort of students based around what they thought that the game was trying to teach. Some of the games, for example Darfur is Dying, were richer in content when compared to the two others meaning that the number of questions associated with some of the games was more limited. This may also indicate that the original design of those games did not necessarily focus as much on the educational side as they did on the game itself.

There is a range of heuristics available for designing entertainment games including for the design of the game interface, game mechanics and game playability. However these were derived from specific game types or genres. Given the dates when these studies were conducted, and the fast pace of the game industry, some of their findings may no longer be relevant to more current games.

The authors research only identified one study that was associated with the heuristic development of serious games (Omar and Jafaar 2010), which was a theoretical model which had not been tested on any actual games. However the findings of the authors' current study concur with their suggestions that serious game should have learning outcomes be outcome based. In other theoretical work on serious game development, authors stressed the importance of fun and the intention to play the game (Giannakos 2013) which we have assessed in our study. Other suggestions, for example, reducing the amount of time it takes to teach a subject and lowering the overall teaching costs (All et al. 2015) were not evaluated within the authors' study, since the focus was primarily on assessing the entertainment and educational value of each of the games.

6.0 Conclusion

To the authors' knowledge this study was one of the first to conduct a holistic evaluation of both the entertainment and educational value of serious games. The findings indicate that player satisfaction is dependent upon the quality of the aesthetics; the game's perceived level of fun and its educational value as measured by the level of feedback and information that the game contains. A more effective

educational experience would be dependent upon providing clearer pedagogical goals and better use of contextualized feedback and background information within the game. This study was restricted to three games which were chosen for both their simplicity and subject matter however the initial findings form a strong basis for understanding the requirements for developing serious games in future. However further refinement and testing on other serious games will be needed to form a more comprehensive picture.

An initial framework for developing serious games is summarized in Box 1. This is based upon combining the work in this study with the core heuristics identified from previous research (Federoff 2002; Desurvire et al. 2004; Pinelle et al. 2008; Desurvire and Wiberg 2009; Koeffel et al. 2009) and the proposals made for heuristics for serious games (Omar and Jafaar 201; Giannakos 2013).

Box 1. Recommendations for developing serious games

- *Make the game fun to play, easy to learn with no repetitive or boring tasks;*
- *Provide a variety of challenges to maintain player interest and enhance the game's replay-ability;*
- *Make the game aesthetically pleasing using high quality audio and graphics;*
- *Use different graphical, audio and visual channels to promote immersion; provide feedback to users on how to play the game and as a way of supplying important background information on the educational topic;*
- *Have clear meaningful goals and objectives within the game which are supported by hints and immediate feedback which support the player if they get stuck or confused;*
- *Provide clear ways that players can identify their score, status, progress and achievements within the game as well have clear win / lose conditions;*
- *Ensure that the player can easily navigate the game world and environment and can customize it to their needs if required;*
- *Make sure the controls are appropriate to the game, where possible customizable and easy for the player to use so that they feel that they are in control of the game;*
- *Pay attention to accessibility issues; user interface and user experience when designing games especially for players who may have a disability;*
- *If artificial intelligence is used then it should be functional enhancing the game rather than disrupting it;*
- *Provide learning outcomes from the beginning so players know what they are expected to learn from the game;*
- *Learning should be reinforced by providing appropriate feedback and subject specific information within the game. Provide alternative ways of presenting that information for example video or animations.*

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